National Aeronautics and
Space Administration

Educational Product	
Educators	Grades K-4

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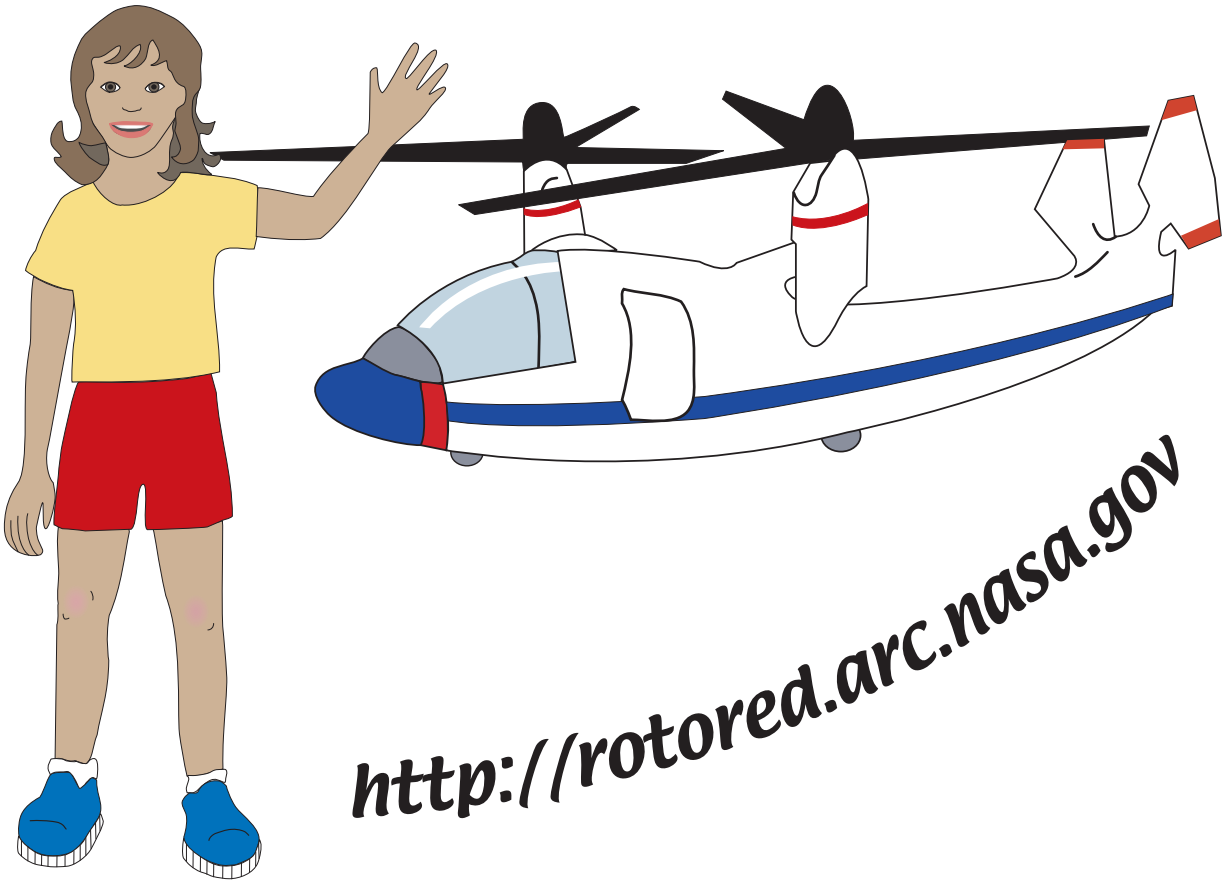
Robin Whirlybird on her Rotorcraft Adventures Educator Guide

An Educator Guide with Activities in Aeronautical Sciences



http://rotored.arc.nasa.gov

Robin Whirlybird on her Rotorcraft Adventures Educator Guide is available in electronic format through NASA Spacelink--one of NASA's electronic resources specifically developed for the educational community.

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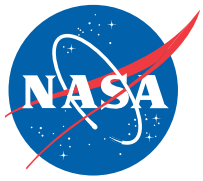

National Aeronautics and Space Administration
Office of Education

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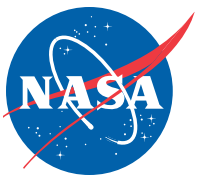
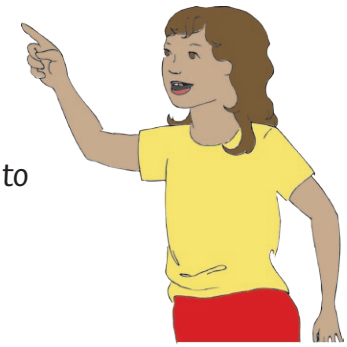


Introduction to Rotorcraft Explorations

The purpose of these inquiry-based explorations is to stimulate students' curiosity and to engage them in activities that involve using the scientific method. In the first exploration students investigate the meaning of a model and how models are used in scientific research. In the next six explorations students investigate the factors that affect the flight of a rotorcraft, adjusting only one factor (or variable) at a time. This is referred to as "fair testing." In the last exploration students are asked to design a rotorcraft that will stay aloft for several seconds. They use the testing methods they learned in the previous explorations and their knowledge of rotorcraft flight to design their rotorcraft.

All the explorations use the inquiry-based approach to student learning. Classroom inquiry is driven by students' curiosity in the world around them, their desire to know more, to figure something out, or to answer a question. The teacher facilitates the process by guiding students' explorations and providing the tools and materials they need in order to have a satisfying inquiry experience. All the materials required for the explorations are readily available.

Exploration 1: What is a Model?



Students investigate the difference between toys, miniature replicas and scientific models. They learn that scientists and engineers use scientific models to understand how things work.

Main Concept

A scientific model is something that is used to understand how the real thing works.

Goal

Students will use the inquiry method to explore what a model is and how a model is used in scientific research.

Objectives and Standards

Objectives	Standards
1. Students will state characteristics that describe a scientific model and differentiate a model from other objects. 2. Students will develop abilities necessary to do scientific inquiry. 3. Students will develop an understanding of scientific inquiry.	**Partially Meets:** NSES: A (K-4) #1 & #2 **Addresses:** ITEA: #9 2061: 1B (K-2) #1

Prerequisite Concepts

- Airplanes and rotorcraft can fly.

Links to Resources that Address Prerequisite Concepts

The Robin Whirlybird Web site:
http://rotored.arc.nasa.gov/

New Concepts

- A scientific model is an object or idea used to understand something about the real thing.

- A model of an airplane can be used to understand how a plane flies.

Links to Lessons and Resources that Also Address Concepts

- NASA CD-ROM *Exploring Aeronautics*:
  - ☆ How an Airplane Flies
  - ☆ Tools of Aeronautics

- Web sites:
  - ☆ Aviation for Little Folks (K-4 level)
    http://spacelink.nasa.gov/Instructional.Materials/On-line.Educational.Activities/Aviation/index.html
  - ☆ How Things Fly
    http://www.nasm.si.edu/galleries/gal109/
  - ☆ Problems and Solutions in Aircraft Design (K-2 level)
    http://quest.arc.nasa.gov/projects/aero/centennial/problem.html
  - ☆ Features and Limits of Aircraft Design (3-5 level)
    http://quest.arc.nasa.gov/projects/aero/centennial/features.html

Schedule

Allow 2-3 sessions of 20-30 minutes each.

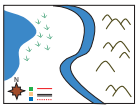
Materials

- Protective eyewear for each student, available from most school science supply stores and catalogs

- Chalk or tape

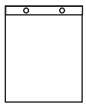
- Drawing paper and crayons or coloring pencils

- A map of a city or state



- Wheels and axles from a LEGO® or other construction toy

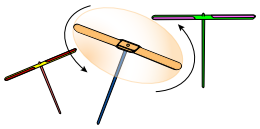
- Chart paper



- A variety of lightweight plastic, metal and wood toy replicas of various sizes and types of helicopters (these won't fly because they are toys) available at most toy stores

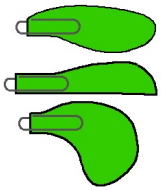
- A variety of heavyweight plastic, metal and wood toy replicas of various sizes and types of helicopters (these won't fly because they are toys) available at most toy stores

- A "flying dragonfly" toy rotor that flies (Shown at the right), available from most toy and hobby stores.



- A rubber-band-powered balsa helicopter called a "penni" helicopter available as a kit and flies reasonably well
  See: http://members.cox.net/arrio2/historic/penni.pdf

- If possible (this is optional), a "maple-seed" helicopter
  See: http://www.grc.nasa.gov/WWW/K-12/TRC/Aeronautics/Maple_Seed.html



- If possible (this is optional), a circular-winged paper airplane
  See: http://www.yesmag.bc.ca/projects/looper.html

- *Photographs or drawings of the following objects:*
  - ☆ *Helicopter or helicopter part mounted on a strut in a wind tunnel*
    http://rotored.arc.nasa.gov/activity/WindTunnelA.html
  - ☆ *Helicopter or helicopter part mounted on a strut in a wind tunnel, see entry year 1976 of rotorcraft timeline*
    http://rotored.arc.nasa.gov/timeline/parents.html
  - ☆ *Helicopter or helicopter part mounted on a strut in a wind tunnel, see entry year 1993 or 1995 of rotorcraft timeline*
    http://rotored.arc.nasa.gov/timeline/yourLife.html
  - ☆ *Flight Simulator*
    http://rotored.arc.nasa.gov/activity/simulator.html

Safety Precautions

When using flying objects in a classroom, post very strict rules and review them with the students. All students MUST wear protective eyewear while any object is in flight. Clearly delineate one or more staging areas, preferably with students' input. Mark on the ground with chalk or tape, where all "test flights" will take place. Caution students to "secure the area" before beginning any "test flight."

Engage

1. Ask students what they know about models.
   Question: What is a model?
   Students' answers will probably include toys and miniature replicas.

2. Have students draw pictures of models.
   - Distribute the drawing paper and crayons or colored pencils and ask students to draw a picture of a model.

   - Ask students to explain why they consider their drawings to be models.

     Students' responses will probably reflect their misconceptions about models. Common misconceptions are the following:
     ☆ A miniature replica of a full-sized object is a model.
     ☆ A toy is a model.

   - Save students' drawings of models and use them for evaluation at the end of the lesson.

3. Tell students that today they will learn about scientific models and explain that scientific models help us understand something about the real thing.

4. Provide examples of scientific models.
   - Show the map and ask if that is a model.
     A map is a model because it tells us where the roads are so we understand more about the real thing.

   - Show the wheels and axle and ask if that is a model. This is a model because it helps us understand how wheels on a real car or truck work.

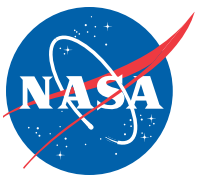
5. Ask for an example of a model.
   - If students still provide examples of miniature replicas or toys, ask them how the object can be used to understand something about the real thing. Simply looking like the real thing is not enough.
   - Explain that miniature replicas and toys are not *scientific* models because they do not help engineers and scientists understand something about the real thing.

6. Have students make a list of objects that make good scientific models.
   - Explain that students will be researchers in aeronautics (flight or flying). Their task will be to find a good aeronautical model for test flights.

   - As a class, develop a list on chart paper of possible objects or assembled items that could be used to test new ideas about aeronautics.

Explore

1. Place the following objects from the "Materials" list on a table:
   - Lightweight plastic, metal and wood toy replicas of various sizes and types of helicopters
   - Heavyweight plastic, metal and wood toy replicas of various sizes and types of helicopters
   - A "flying dragonfly" toy rotor that flies or a rubber-band-powered balsa helicopter called a "penni" helicopter
   - Photographs or drawings of the following objects:
     - ☆ Helicopter or helicopter part mounted on a strut in a wind tunnel
     - ☆ Helicopter or helicopter part mounted on a strut in a wind tunnel, from the entry year 1976 of rotorcraft timeline
   - If possible, add the items listed by the students during the "Engage" segment.
2. Ask students to work in pairs and instruct them as to what they will be doing.
   - Set safety precautions before the students start to explore
   - Challenge students to find a way to determine which of the objects would make good models or could be put together to make good models and used for flight explorations.
   - Delineate a process with the students or have them come up with their own during their exploration.
   - Ask students to draw a picture that depicts the results of their exploration. Ask them to indicate on their drawings the items they think would make good scientific models.
   - Give students approximately 10 - 20 minutes to explore the objects.
3. Gather students together for a discussion.
4. Ask them to focus on each proposed model with the question: Is this a model?
5. Ask the group to draw a conclusion about which models are the best to experiment with to study flight.



Explain

1. *Ask the class to draw a conclusion about the characteristics of a model used for scientific experiments.*

2. *Write the list of characteristics on chart paper.*

   Some of the noted characteristics could include the following:
   - *Its performance is highly similar to the actual object.*
   - *Its parts are functional and perform just like the parts on the actual object.*
   - *A particular part is functional and performs just like it would on the actual object.*
   - *Accurate measurements of its performance can be made (that can also be scaled to the actual object's size).*
   - *Models can be used to learn about the real thing.*
   - *Models may not look like the real thing.*

3. *Reveal the remaining objects from the "Materials" list and ask students to use their list of characteristics to compare and test to see if any of these new items/objects depicted could be used as a model for scientific experiments:*

   - ***Photograph of a flight simulator***
     This is a model for scientific experiments because it simulates flight and helps us learn about flight.
   - ***A metal toy airplane*** *(incapable of flight)*
     This is not a model for scientific experiments. Since it cannot fly, it does not perform like the actual object.
   - ***A plastic toy helicopter*** *(incapable of flight)*
     This is not a model for scientific experiments. Since it cannot fly, it does not help us learn about flight.
   - ***A "maple-seed" helicopter***
     This is a model for scientific experiments because it can be made to fly and may help us learn something about rotorcraft flight.
   - ***A circular-winged paper airplane***
     This is a model for scientific experiments because it can be made to fly and may help us learn something about flight.

Extend

1. Have a local researcher bring samples of models used in their work and discuss how the models helped them learn new things safely before trying the new ideas on the actual object or machine.

2. Ask students if they can think of ways that models are used to understand how the human body works. They may come up with pumps used to understand how the heart works, models of DNA, and models of the brain.

3. Discuss how models are used to build new cars, first with drawings on paper and computer. Parts of the car are modeled before the whole thing is put together. Ask students if they can think of the parts that would be modeled separately.

Evaluate

1. To evaluate students' understanding of a model, give them the following scenario:
   - Students are scientists and they are going to design a new: bicycle, roller blades, skateboard, car or any other vehicle they choose. They need to draw a model that will help them design their vehicle.

   - Ask students to list or indicate on their drawings why they think their model is a good model. Remind students that their models may not look like the real thing, but must help them understand something about the real thing.

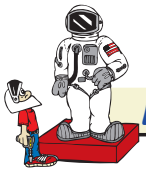
   - Have students present their drawings to the class and explain how they are good models.

2. Look for the following in students' drawings and lists:
   - An indication of how the objects drawn will enable students to learn something about the real thing.

   - The drawings may consist of part of a vehicle, such as the gear mechanism on a bicycle, the brakes, or the surface of a skateboard. For example, the surface of a skateboard must have a suitably rough surface so the rider's shoes don't slide off.

3. Compare students' drawings with the drawings they made in the "Engage" segment of the exploration.

4. Wrap up the exploration.
   Say: In the next exploration we will use models to understand how rotorcraft fly.

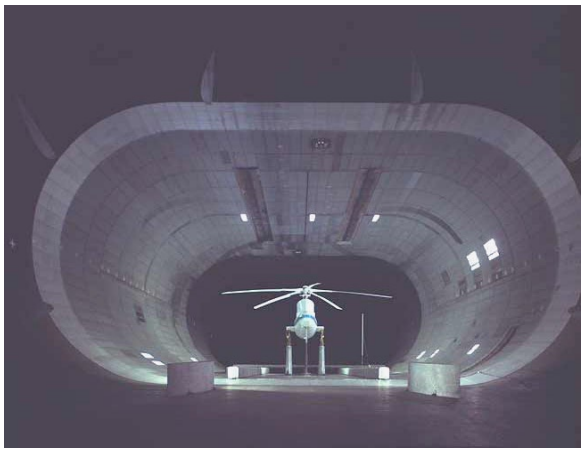


Further Exploration

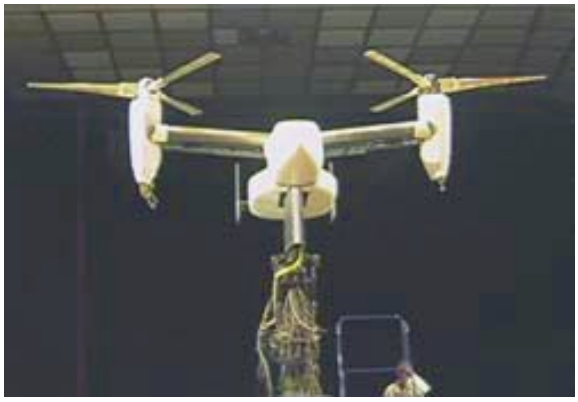
Students might have additional questions regarding the connection between models and actual objects being researched by scientists. If time and interest permits, transform their ideas, questions, observations and/or hypotheses into another investigation.

Reference Photographs

Tiltrotor in wind tunnel



Sirorsky helicopter in wind tunnel



Tiltrotor model in wind tunnel

S-76 rotor test